

OPTICON: EC OPTICAL INFRARED COORDINATION NETWORK FOR ASTRONOMY

<http://www.astro-opticon.org>

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1. ABSTRACT

OPTICON, the ICN OPTICAL INFRARED COORDINATION NETWORK FOR ASTRONOMY, brings together for the first time the operators of all Europe's medium to large optical-infrared telescopes, the largest corresponding data archives, and several user representatives. The OPTICON partners work with their communities to identify those major challenges for the future development of European optical-infrared astronomy which require Europe-wide collaboration. OPTICON sponsors and coordinates developments towards these goals, involving the entire astronomical community through workshops and meetings targeted towards these agreed common goals of general importance.

2. INTRODUCTION

OPTICON, the Co-ordination Network for optical and infrared astronomy, is an EC funded *Infrastructure Cooperation Network* under the *Enhancing Access to Large Infrastructures* part of the Framework 5 (FP5) Human Potential Programme. Such networks are funded to bring together infrastructure operators and 'typical' users. OPTICON brings together Europe's multinational, national and major regional providers of astronomical infrastructures, together with four 'representative' research institutes. The classes of infrastructure of direct relevance to OPTICON include optical and infrared telescopes, their instrumentation, existing medium-sized observatory infrastructures, data archives and their relevant communication infrastructures, and optimization of the scientific development and exploita-

tion of these facilities. By identifying and encouraging common approaches to those challenges which require Europe-wide collaboration, the OPTICON partners work to enhance both the quality and the quantity of access to those research infrastructures across the whole EU community.

3. BRIEF HISTORY

In 1999 the EC 5th Framework Program funded the thematic network Optical and Infrared Co-ordination Network for Astronomy (OPTICON: HPRI-1999-40002). This network brings together 14 partners, representing the major astronomical funding and management organizations within the European Union. The OPTICON network is sponsored to facilitate co-ordination of key developmental issues in European astronomy.

As part of its FP5 initiative, the EC made a deliberate effort to encourage improved coordination and collaboration in the development of, and access to, European-scale and internationally competitive research infrastructures. In practise, this meant extending the established system of *Infrastructure Cooperation Networks*, which existed in many branches of science which received significant EC funding support.

The role of these networks was described at the time as:

INFRASTRUCTURE COOPERATION NETWORKS

The objective of this scheme is to catalyze the self-coordination and the pooling of resources between infrastructure operators in order to foster a culture of cooperation between them, to generate critical mass for research into higher performance techniques, instrumentation and technologies, to spread good practice, to promote common protocols and interoperability, to encourage complementarity, and to stimulate the creation of "distributed" and "virtual" large facilities.

Participants in these networks will be operators of research infrastructures, research teams in universities, in research centres and in industry, representatives of users of the infrastructures, and equipment manufacturers. Each network will contain at least three mutually independent legal entities which operate research infrastructure and which come from at least three different countries of the Member States and Associated States (one of which at least must be a Member State) and must be co-ordinated by one of these legal entities.

Infrastructure cooperation networks will be implemented as thematic networks.

One such network, EVN-JIVE, was in place supporting radio astronomy, and in particular Very Long Baseline Interferometry (VLBI), and its

central data processing facility at JIVE, the Joint Institute for VLBI in Europe, based in the Netherlands. JIVE/EVN has as partners all the facilities (including several outside the EU geographical borders) which manage radio telescopes in the VLBI network. Many of the users work in the same Institutes, so that user representation is provided naturally.

To establish a comparable scale network in the rest of astronomy, ensuring full community participation and support, is not easy: there are very many Institutes in Europe active in astronomy, very many observatories, and many major data centres. In order to ensure that OPTICON had validity from its start, the EC invited to meetings in Brussels one or more representatives from every major astronomy-related funding agency, as well as the PIs of every EC-funded astronomy-related network and grant. Over 100 people were involved in these meetings. By February 1999 clear agreement had been reached that establishing such a network was desirable, the major infrastructure operators in Europe had all agreed their support, identified the issues which they wished the network addressed as a minimum, and the present author was asked to write and coordinate the proposal.

The proposal was submitted to the early May 1999 proposal round, and approved. Funding for travel and workshops over four years was provided to ensure open community-wide participation in agreed goals. The OPTICON partners met formally for the first time in April, 2000.

Identification of the partners was, in most cases, self-evident. Organizations which operate observatories and large data centres are readily identifiable. There was only one existing grant holder under the extant Access Program, and that Institute (Instituto de Astrofísica de Canarias, manager of the European Northern Observatory Access grant), while not yet an operator of medium sized or large telescopes (pace GRANTECAN), or a data centre, does operate an observatory site, the Canarian Observatories.

One issue which arose at once, and which remains subjective, was selection of the ‘representative user groups’. Clearly no such selection has any meaning when hundreds of comparable Institutes exist. In practise however, the role of the users among the partners has been restricted to hosting open scientific workshops, and to scientific support for a single item in OPTICON’s activities, development of the science case for future Extremely Large Telescopes. Since this role provides no direct benefits for the user representatives, the relevant organizations do indeed act on behalf of the wider community. The user Institutes were in fact recommended for inclusion, by the EU meeting, to be the EARA members, as being an available, independently-defined, European-wide group of major research Institutes with a tradition in international collaboration.

The European Association for Research in Astronomy (EARA), was founded in December 1991, joining the CNRS astrophysics laboratoire, In-

stitut d'Astrophysique de Paris, with the astronomy departments of the Universities of Cambridge and Leiden, in the frame of a CNRS initiative for "Associated European Laboratories". EARA was later extended to include the Instituto de Astrofisica de Canarias, and the Max Planck Institut für Astrophysik, all five of whose members are OPTICON partners.

4. ORGANIZATION AND FUNDING

The Opticon Network includes 14 formal participants and a number of associated partners. The formal participants include the major European and National astronomical agencies plus representative user institutes. The five EARA institutes are among the latter.

TABLE 1. The OPTICON Partner Organizations

Contact Individual	Partner Organization
OPTICON COORDINATOR ORGANISATION Dr Paul Murdin	Particle Physics and Astronomy Research Council
OPTICON CHAIRMAN/CONTACT Professor Gerard Gilmore	The University of Cambridge/Institute of Astronomy
Professor Francoise Genova	Universite Louis Pasteur - Strasbourg CDS
Professor Piero Benvenuti	European Space Agency - Space Sciences Division
Professor Alvio Renzini	European Southern Observatory
Professor Alain Omont	CNRS/Institut d'Astrophysique de Paris
Dr Genevieve Debouzy	Institut National des Sciences de l'Univers du Centre National de la Recherche Scientifique
Professor Francisco Sanchez	Instituto de Astrofisica de Canarias
Professor Marcello Rodono	Consorzio Nazionale per L'Astronomia e L'Astrofisica
Professor George Miley	Universiteit Leiden/Astronomy Department
Professor Simon White	Max Planck Institut für Astrophysik
Professor Hans-Walter Rix	Max-Planck-Institut für Astronomie
Professor Dr Tim De Zeeuw	Netherlands Research School for Astronomy (NOVA)
Dr Leo Takalo	Nordic Optical Telescope Scientific Association

The contract partners are independent national agencies or research

institutes, and multi-national organizations. Each partner is represented by national research and funding directors, research group directors or the equivalent.

Overall Network coordination is provided largely by the science coordinator assisted by the OPTICON Administrator and secretary. This small team ensures adequate information and administrative support for the working groups' and partners' meetings, enhances reliable and effective communications across the network, maintains the webpage and enhances Europe-wide information about the OPTICON activities.

The OPTICON management board meets twice a year with the inaugural meeting being held at the National Maritime Museum, Greenwich, London in April 2000. The schedule of future meetings is given in our diary available on the Opticon webpage www.astro-opticon.org

The Network operates a two-level structure. This means that the contract partners meet to specify timely areas of common interest and opportunity for development and cooperation. These areas of mutual interest are developed and quantified where appropriate by specialist working groups, chaired by a partner, bringing together relevant complementary expertise and users from the whole European astronomical community, explicitly including countries and Institutes not explicitly included in the present partners.

Each working group is led by a delegated partner, who is responsible for specific management, and for reporting to the network overall. In practice, there is a considerable degree of overlap in membership of the working groups, so that informal communications are excellent. Regular communications are utilized on a daily basis with more permanent, and public, information being provided on a series of web sites. There is a dedicated network home page <http://www.astro-opticon.org>. Each working group also has its own home page as follows:

www.roe.ac.uk/atc/elt/workshop/index.html

www.ip.de/Euro3D/

www.stecf.org/jwalsh/OPTICON3D

ecf.hq.eso.org/astrovirtel/

www.roe.ac.uk/ifa/surveys

4.1. PROFILES OF THE OPTICON PARTNERS

A summary profile of the fourteen Opticon partners is provided below:

1) PARTICLE PHYSICS AND ASTRONOMY RESEARCH COUNCIL

The Particle Physics and Astronomy Research Council (PPARC). PPARC funds UK research, education and public understanding in its four broad

areas of science - particle physics, astronomy, cosmology and space science. PPARC has three scientific sites: the UK Astronomy Technology Centre (UKATC) in Edinburgh, the Isaac Newton Group of telescopes (ING) in La Palma and the Joint Astronomy Centre (JAC) in Hawaii. <http://www.pparc.ac.uk>

2) INSTITUTE OF ASTRONOMY, UNIVERSITY OF CAMBRIDGE

The Institute of Astronomy is a department of the University of Cambridge. It is the largest centre for astronomical research in the UK and is among the oldest scientific research departments of the University. The 120 staff, students and visitors are drawn from many countries making it an international research centre dedicated to teaching and research in many areas of observational and theoretical astronomy. <http://www.ast.cam.ac.uk>

3) CENTRE DE DONNÉES ASTRONOMIQUES DE STRASBOURG (CDS)

The Centre de Données astronomiques de Strasbourg (CDS) is a data centre dedicated to the collection and worldwide distribution of astronomical data and related information. It is located at the Strasbourg Astronomical Observatory, France.

The CDS develops reference databases and tools, widely used by the astronomy community, and collaborates actively with other data centres, ground and space-based observatories and electronic journals to build links between distributed on-line resources. <http://www.astro.u-strasbg.fr/obs-E.HTML>

4) EUROPEAN SPACE AGENCY - SPACE SCIENCES DIVISION

ESA, the European Space Agency, provides a vision of Europe's future in space, and of the benefits for people on the ground that satellites can supply. It also develops the strategies needed to fulfil the vision, through collaborative projects in space science and technology.

Most OPTICON-related activity is organized through the ESA/NASA Space Telescope-European Coordinating Facility

The Science Archive Facility has over twelve years of experience in the management and development of astronomical archives and databases. Throughout this period the Archive has pursued a steady and effective collaboration with the CADC (Canadian Astronomy Data Centre) and has implemented a number of innovative features. These additions have all proven so useful and popular that they have been adopted by other archive sites and have become part of a set of 'minimum requirements' for modern astronomical archive systems. <http://www.esa.int> <http://www.stecf.org/astrovirtel/> <http://www.stecf.org/>

5) EUROPEAN SOUTHERN OBSERVATORY

ESO, the European Southern Observatory, was created in 1962 to establish and operate an astronomical observatory in the southern hemisphere,

equipped with powerful instruments, with the aim of furthering and organizing collaboration in astronomy

It is supported by eight countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden and Switzerland; the United Kingdom is to join ESO in 2002. Portugal has a cooperation Agreement with ESO, leading to future membership.

ESO operates at two sites. It operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where fourteen optical telescopes with diameters up to 3.6 m and a 15-m submillimetre radio telescope (SEST) are now in operation. In addition, ESO is in the process of building the Very Large Telescope (VLT) on Paranal, a 2,600 m high mountain approximately 130 km south of Antofagasta, in the driest part of the Atacama desert. The VLT consists of four 8.2-meter and several 1.8-meter telescopes. These telescopes can also be used in combination as a giant interferometer (VLTI). "First Light" of the first 8.2-meter telescope (UT1) occurred in May 1998. UT1 became available on a regular basis for astronomical observations from April 1999. Over 1000 proposals are made each year for the use of the ESO telescopes.

The ESO Headquarters are located in Garching, near Munich, Germany. This is the scientific, technical and administrative centre of ESO where technical development programmes are carried out to provide the La Silla and Paranal observatories with the most advanced instruments. There are also extensive astronomical data facilities. In Europe ESO employs about 200 international Staff members, Fellows and Associates; in Chile about 50 and, in addition, about 130 local Staff members. <http://www.eso.org/>

6) INSTITUT D'ASTROPHYSIQUE DE PARIS

The Institut d'Astrophysique de Paris (IAP) is a laboratory of the Centre National de la Recherche Scientifique (CNRS). Founded in 1938 with the development of modern astrophysics and the foundation of CNRS, IAP has a long history of prominent activity in observation and theory and of international collaboration. Its present activity focuses on extragalactic astronomy and cosmology, including stellar populations and star formation in galaxies, and specific aspects of stellar physics.

The IAP hosts data reduction centers for several major international experiments, including the infrared survey of the southern sky (DENIS), French participation in the NASA ultra-violet mission FUSE, TERAPIX, the data reduction center for the 1 x 1 MEGACAM camera to be installed on the Canada France Hawaii Telescope (CFHT), and participation in the data analysis of the ESA PLANCK cosmic microwave background space mission. <http://www.iap.fr/accueil.html>

7) INSTITUT NATIONAL DES SCIENCES DE L'UNIVERS (CNRS)

The Institut National des Sciences de l'Univers (INSU) is part of the Centre National de la Recherche Scientifique (CNRS), the main scientific public research organization in France. INSU has the responsibility in three scientific areas: ocean-atmosphere, earth science and astrophysics. Its 128 research and service units (most of them associated with Universities) represent a total staff of 5608 individuals. INSU is also strongly involved in large international collaboration and participate to the funding and operation of some of the major large ground-based infrastructure facilities. <http://www.insu.cnrs-dir.fr/>

8) CONSORZIO NAZIONALE PER L'ASTRONOMIA E L'ASTROFISICA (CNAA) and ISTITUTO NAZIONALE DI ASTROFISICA (INAF)

The Italian "National Consortium for Astronomy and Astrophysics" (CNAA) is based in Rome and was established in 1996 by the 12 Italian Astronomical Observatories of the Ministry of University and Research (Arcetri-Florence, Bologna, Brera-Merate, Cagliari, Capodimonte-Naples, Collurania-Teramo, Catania, Padua, Palermo, Rome, Turin, Trieste) as a temporary Institution devoted to the promotion and management of national projects, primarily the newly completed "Telescopio Nazionale Galileo" at the Roque de Los Muchachos Observatory (La Palma, Canary Islands), and of coordinated research activities carried out at different institutions in Italy. The CNAA has also served as a forum for debating questions related to the national science policy in Astronomy.

The Italian Observatories and the CNAA are now being restructured into a single national institution, the "Istituto Nazionale di Astrofisica" (INAF), which is based in Rome and will take over all legal and management responsibilities starting from mid 2001. <http://w3c.ct.astro.it/cnaa>

9) INSTITUTO DE ASTROFISICA DE CANARIAS

The Instituto de Astrofisica de Canarias (IAC) is a highly internationalized research centre and comprises:

The Instituto de Astrofisica, which constitutes the headquarters, based in La Laguna (Tenerife, Spain); the Observatorio del Teide, in Izaa (Tenerife); and the Observatorio del Roque de los Muchachos, in Garafia (La Palma).

The IAC's headquarters is located on the campus of the University of La Laguna, where it has become a meeting point for the international astronomical community, a centre for research, technological development and training of researchers, engineers and technicians. The Grantecan 10 m telescope is the major undergoing technological project. IAC is also an active promoter of science education. <http://www.iac.es>

European Northern Observatory

The IAC Observatories (the Observatorio del Teide, on Tenerife, and the Observatorio del Roque de los Muchachos, on La Palma), together with

the research facilities from 18 different countries, constitute the European Northern Observatory (ENO), Europe's organization for Astronomy in the North. <http://www.iac.es/eno/>

10) LEIDEN OBSERVATORY

The Institute of Astronomy at Leiden University, the Sterrewacht Leiden (Leiden) Observatory), has a long tradition and an internationally acknowledged reputation for education and research in astronomy.

The Institute offers all the facilities needed to participate in top level research. The research interests of the Sterrewacht Leiden cover many aspects of modern astronomy, ranging from stars and the interstellar medium, to galaxies and cosmology. <http://www.strw.leidenuniv.nl/>

11) MAX-PLANCK-INSTITUT FÜR ASTROPHYSIK

The Max-Planck-Institut für Astrophysik is one of more than 70 autonomous research institutes within the Max-Planck-Society. These institutes are primarily devoted to fundamental research. Most of them carry out work in several distinct areas, each led by a senior scientist who is a "Scientific Member" of the Max-Planck Society.

Research at MPA is devoted to a broad range of topics in theoretical astrophysics. Major concentrations of interest lie in the areas of stellar evolution, stellar atmospheres, supernova physics, astrophysical fluid dynamics, high energy astrophysics, galaxy structure and evolution, the large-scale structure of the Universe, and cosmology. <http://www.mpa-garching.mpg.de>

12) MAX-PLANCK-INSTITUT FÜR ASTRONOMIE

The Max-Planck-Institut für Astronomie (MPIA) in Heidelberg operates the Calar Alto Observatory as well as conducting research in different areas of astronomy and astrophysics. It is one of the Max-Planck-Institutes in Germany within the Max-Planck-Gesellschaft (MPG) and one of the five astronomically orientated institutes in Heidelberg <http://www.mpia-hd.mpg.de> <http://www.caha.es>

13) NETHERLANDS RESEARCH SCHOOL FOR ASTRONOMY (NOVA)

The Netherlands Research School for Astronomy, Nederlandse Onderzoeksschool voor Astronomie or NOVA's scientific program is based on three multiply-connected inter-university networks. It is built around key researchers with international reputations, who lead groups in their respective institutions (at the Universities of Amsterdam, Groningen, Leiden and Utrecht), and who already have ongoing collaborations.

Nova's mission is two-fold: i) to carry out front-line astronomical research in the Netherlands and ii) to train young astronomers at the highest international level. <http://www.strw.leidenuniv.nl/nova>

14) NORDIC OPTICAL TELESCOPE SCIENTIFIC ASSOCIATION

The Nordic Optical Telescope (NOT) Scientific Association (NOTSA) was founded in 1984 to construct and operate a Nordic telescope for observations at optical and infrared wavelengths.

The associates members are: Statens naturvidenskabelige forskningsråd (Denmark); Suomen Akatemia (Finland); Háskóli Íslands (Iceland); Norges forskningsråd (Norway); Naturvetenskapliga forskningsrådet (Sweden).

The executive bodies of NOTSA are the NOT Council and the Directorate. <http://www.astro.utu.fi/> <http://www.not.iac.es>

5. OPTICON ACTIVITY: WHAT and HOW?

Since the start of the network, six major aspects of European astronomical research in which there are clear benefits from international cooperation, and where inadequate cooperation currently exists, have been identified. These are:

Activity 1: EU Elite Fellowship Program

Activity 2: The Astrophysical Virtual Observatory

Activity 3: Improved Coordination on Common Infrastructures

Activity 4: The Future of Medium-sized Observatories in the enlarged EU

Activity 5: The Science Case for Extremely Large Telescopes

Activity 6: Joint Activities with the radio astronomy ICN (JIVE).

Working Groups, with full representation across the whole EU astronomy community, have been established to implement these common objectives, with substantial progress being made.

5.1. ACTIVITY 1: EU ELITE FELLOWSHIP PROGRAM

The working group responsible for Elite Fellowships operates to ensure that the best European fellowships on offer are of comparable status and duration to those on offer in the US and through some European National Programmes. The goal is to make European astrophysics as attractive a career option for the most talented young scientists as options which are available in other communities.

This scheme should enhance the production of excellent science within Europe and help identify research leaders of the future.

5.1.1. OVERVIEW OF PROGRESS

A proposal for six, three-year postdoctoral fellowships, namely the J H Oort Fellowships, had been submitted to the EU Marie Curie scheme, but these had not been immediately supported. EU feedback strongly supported the scientific goals of the proposal, but implied that the application was not suitable for the programme to which it had been submitted.

The failure of present EU structures to provide internationally competitive fellowship and career opportunities for the most able astrophysicists was identified, with the specific limitations in current schemes being successfully localized.

Following a meeting between the Director General of ESO and the head of DG-XII, the working group chair had put together a new generic proposal for an *elite* fellowship scheme which was hoped could be considered as an *Accompanying Measure* in Framework VI. The scheme could initially be run as a pilot in two or three disciplines, including astrophysics.

The EU had said that it did not have the resource or facility to manage such a scheme and would seek to allocate this responsibility to a suitable Agency if the scheme was supported, though it was not clear who this might be for astrophysics. Consequently, a proposal to investigate possible management structures in several disciplines was submitted to the Call for Accompanying Measures, approved and funded, and is underway.

Efforts continue to create and implement a scheme whereby EU-funded Europe-wide fellowships for the most able astrophysicists will be competitive with US opportunities.

5.2. ACTIVITY 2: THE ASTROPHYSICAL VIRTUAL OBSERVATORY

The OPTICON partners agreed to coordinate their efforts towards the realization of an Astrophysical Virtual Observatory for all European astronomy. An Astrophysical Virtual Observatory would allow all European astronomers to partake in, and utilize, the technological advances of the future internet (GRID) initiatives that have already been recognized by the EC as critical to the development of the European Research Area. Similar efforts are under way in the US, in response to an NSF decadal report on astronomy, and in other subjects.

5.2.1. *First Step*

The ASTROVIRTEL Project, supported by the European Commission and managed by the ST-ECF on behalf of ESA and ESO, was the first stage in the fruition of the AVO. ASTROVIRTEL was aimed at enhancing the scientific return of the ESO/ST-ECF Archive and offers to European users the opportunity to exploit it as a virtual telescope, retrieving and analyzing large quantities of data with the assistance of the Archive staff.

ASTROVIRTEL is primarily concerned with implementation of science-driven query tools spanning multiple extant data Bases, and means to label the scientific integrity of dBases. The approach taken consists of building from specific astronomer led queries starting with a few high quality and

well understood dBases. At present this includes the HST and ESO/VLT archives followed by the rest of the ESA mission archives.

A first call for proposals was announced in mid-2000, with 11 proposals received and 5 selected for further assessment and implementation.

The advantages of the ASTROVIRTEL approach are that: the "scientific interoperability" of different archives will be enhanced on the basis of specific scientific requirements as contained in the approved Proposals, the "mining tools" and the procedures for the management and analysis of the retrieved data sets. These will then become part of the Archive and offered to the community. See ecf.hq.eso.org/astrovirtel/

It is envisaged that ASTROVIRTEL will naturally evolve into a part of the larger AVO. In the meantime ASTROVIRTEL, with 3 years funding, is providing an essential learning experience.

5.2.2. *Second Step*

With the background of ASTROVIRTEL, European-wide efforts are now in place by the working group responsible for implementing an AVO. They are specifically preparing for the following:

- 1) A complete science case and set of science requirements;
- 2) A demonstration of interoperability using a small set of existing archives with varying degrees of VO-readiness;
- 3) An assessment of GRID technologies for astronomy including prototyping, testbeds and the development and assessment of scalable storage and processing facilities;
- 4) Implementation of active links to similar international initiatives (e.g. NVO in the US) to prepare for the possibility of global VO activities.

OPTICON established three working groups to investigate practical implementation of these goals, and definition and implementation of the Astrophysical Virtual Observatory: one to focus on the scientific utilization of archives; one on the interoperability of archives; and one on the necessary IT infrastructure for the exploitation of an ever-increasing astronomical data flood. A meeting of the OPTICON partner organizations in Strasbourg in October 2000 made explicit recommendations to these working groups to prepare, by early 2001, proposals to the 5th Framework RTD program for developments leading to the Astrophysical Virtual Observatory, in such a way as to benefit the entire EC-wide astronomical community.

Six key organizations were identified as members of the AVO Phase A proposal in order to meet the requirements of the RTD program and the aims outlined. The UK ASTROGRID consortium was an existing collaboration that was seeking e-Science funds from the UK government to deploy GRID technologies for several astronomical programs. The joining of the ASTROGRID consortium into the AVO proposal was a major step in order

to form an important unification of the European VO effort and to optimize the return on available funds, together with forming a unified interface to international efforts.

The RTD proposal was submitted in February 2001 and identified a 6.2 million euro work program over three years consisting of 718 man months of development, testing and deployment, 1 million euros in hardware and 100,000 euros in travel expenses. The immediate goals have been achieved. The RTD proposal has been approved.

An illustration usign the OPTICON Working Group on INTEROPERABILITY

Among the tasks of the OPTICON network are to ensure improved efficiency of access to and enhanced exploitation of ground and space observations, together with the development of virtual access to large data archives. One key element for increasing scientific access to multi-wavelength, heterogeneous data is interoperability of data archives and information services. This allows scientists to retrieve the data of interest for their research among the large variety of possible information sources and be able to formulate queries to these distributed on-line resources. On the service provider side, metadata describing the service contents have to be implemented, and data exchange mechanisms have to be defined and used to allow the implementation of links between services and the integration of data of different origins in common user interfaces.

This analysis was presented at the first general meeting of the OPTICON network at Greenwich in April 2000, where it was agreed that a Working Group to tackle these questions should be created. The Interoperability Working Group aims at studying cost effective tools and standards for improving access to and data exchange from data archives and information services. One important specification was to keep to a minimum the additional workload on data providers. A pragmatic bottom-up approach will be used, with email discussions, targeted meetings to define and promote basic standards and generic tools, short technical visits if necessary, and eventually prototype implementation in some cases. Working Group members are managers of European public databases and archives proposed by the OPTICON collaboration.

The Interoperability Working Group's goals were presented at two major international meetings: Virtual Observatories of the future (Caltech, June 2000), and Mining the sky (Munich, July-August 2000), where numerous contacts and discussions took place with potential participants and international partners (USA, Canada). The list of participants was further discussed after the second OPTICON general meeting with the OPTICON collaboration members. Exchanges of information took place with the proposed members, to explain the Working Group's goals, to acquire confirma-

tion of their willingness to participate, and identify a first set of information to be distributed and of subjects to be discussed. A Web page is in preparation and a meeting is foreseen in the coming months, with presentations of problems and possible solutions by the Working Group members, together with a few round-table discussions on specific topics of general interests.

A targeted meeting was held in Strasbourg with the ECF-ESO Astro-Virtel managers in December 2000, to discuss the usage of common tools taking into account their scientific requirements.

The importance of early partnership with other communities was recognized from the beginning with contacts being immediately taken with the European Radio Network and an OPTICON/EVN discussion organized during the International Astronomical Union General Assembly in Manchester. The "Astronomy Information Network" was presented at an EVN meeting in Madrid in November 2000. The radio network nominated a representative to participate in the Working Group activities and to diffuse the information in the radio community. Data archive managers from Australia, Canada and USA were invited to participate in the Working Group activities and have fully contributed.

From these meetings and more generally to present the "Astronomy Information Network" at which to discuss generic tools at the first Astro-GRID meeting in Belfast, January 2001, a coherent Interoperability work program was thus established for the AVO proposal.

Joint EU and US meetings have identified several key coordination points and milestones for the future. A regular series of open international and Europe-wide workshops, conferences, and scientific meetings are scheduled, with OPTICON sponsorship. The committees also submitted a joint proposal for an IAU Symposium on VO Science to be held in conjunction with the IAU General Assembly in Sydney 2003.

For the future, OPTICON will continue to coordinate EU-wide development of the Virtual Observatory and implement the RTD aims.

A Review Paper 'OPTICON and the Virtual Observatory'

(http://xxx.soton.ac.uk/multi_astro-ph/0011464)

is available further describing these activities.

5.3. ACTIVITY 3: IMPROVED COORDINATION ON COMMON INFRASTRUCTURES

5.3.1. *ASTRO-WISE: OPTICON Working Group on Wide Field Imaging*

The aim of this programme is to provide a European astronomical survey system, facilitating astronomical research, data reduction, and data mining based on the new generation of wide-field sky survey cameras. By joining the efforts of several National data centres established in support of these cameras and of the ESO, the programme establishes, through common stan-

dards, a European wide shared computing infrastructure. The huge, many Terabyte, wide field imaging data volumes call for a coordinated effort: the programme coordinates the development of software tools and will support the derivation of survey system products, such as Public Survey results, calibrated images and catalogues of astronomical objects. These products will be used for astronomical research, made available to archive facilities to be addressed by parallel activities such as AVO, and are crucial for the exploitation of the new very large telescopes.

Following a successful OPTICON meeting on Survey systems in Edinburgh, the National data centers involved in wide-field imaging in the Netherlands (NOVA), Italy (Capodimonte), France (TeraPix) and Germany, together with ESO and the UK-VISTA community have taken the initiative to prepare for a joint effort. A full account of the talks and program of the workshop can be found at the workshop web site:

<http://www.roe.ac.uk/ifa/surveys>.

A new consortium has been founded with all partners being prepared to contribute significantly by providing both hardware and human resources for a new European-wide-field-imaging initiative. An RTD proposal has been prepared and submitted, seeking funding for this international collaboration. This proposal has been approved and supported by the EU.

This remarkably swift development after the OPTICON meeting marks the common needs and the appreciation of partners' expertise in the consortium. Several meetings between individuals from the data centers have taken place and exchange of personnel is planned. All short-term intentions have been realized, most importantly building a new Europe-wide collaboration.

Long term plans include the implementation of the RTD proposal goals, together with continuation of common work towards agreed common goals.

5.3.2. *EURO-3D: OPTICON 3D-SPECTROSCOPY WORKING GROUP*

One of the crucial ways in which European astronomy has acted in coordinating Europe-wide community has been identified by the OPTICON partners. This has been in the development of common software tools to address data challenges common to major instrumental developments. Following recommendation, the OPTICON partners considered the case for 3-Dimensional spectroscopic developments in European astronomy. The partners concluded 3-Dimensional spectroscopy as one of the most technologically challenging developments in optical-infrared astronomy at present, yet is one in which the scientific returns are immense. It is one in which the European scientific community holds a significant and currently world-leading role. It has also been recognized that an essential requirement for

European excellence in this technologically challenging field is improved coordination in development of the common infrastructure tools.

In response to this agreed priority need, and to meet the EC recommendation for a coordinated Europe-wide response, OPTICON established a Working Group, with the following remit:

To bring together representatives of all the European groups working in 3D spectroscopy; to share experience, software and expertise; to enhance common working methods; and to consider ways in which to apply for EC funding; to support developments of clear common benefit to the whole European astronomical community.

The working group accepted the OPTICON remit, and agreed to develop a proposal to the EC Research, Training Networks programme (RTN). In addition, the instrumental, software and future plans of all the groups were reviewed, and a critical item for progress agreed.

The aim of the RTN proposal, called Euro3D, is to coordinate and underpin the many potentially complementary activities underway in Europe, concentrating on providing software while training young researchers to scientifically exploit the many 3D spectroscopy instruments which are coming available on large telescopes. However, the data from these instruments is large and complex and expertise in the community to exploit the scientific potential is not yet sufficiently widespread.

The working group had met twice during 2000 to discuss and review the instrumental, software and future plans of all the groups. Two open and widely advertised meetings were also held in Garching in December 2000 and in Potsdam in February 2001.

5.3.3. *Activity 4: The Future of Medium-sized Observatories in the enlarged EU*

The existing medium sized (2-4metre telescope aperture on good mountain sites) observatories have an enormous potential for improved international cooperation, with particular opportunities in enhanced training for the young and for scientists in Central Europe. Additionally, considerable scientific benefits to the whole European scientific community, together with financial benefits to the national operating agencies, can follow from improved coordination of operational facilities, instrumentation, and procedures.

A working group has been established to achieve these training and common operational aims.

Two working group meetings brought together, for the first time, the operators and observatory directors of every 2-4m telescope in which an EU country has a major financial partnership. These historic occasions led

immediately to an appreciation of common requirements, opportunities and challenges.

Facilities already in existence cover a wide range of science and training applications, but there is little co-ordination with respect to operation or development. It has also been noted that access to some facilities was already open to the entire international community, but no financial support was available for observers to reach the telescopes.

Four sub-groups were established to consider different areas of possible co-operation and collaboration. One of the aims of these groups is to set out the principles for proposals which could be taken to the wider community and funding agencies.

These groups have prepared a working document, which is now being used as the basis of discussions between telescope operators, national funding agencies, and extant user communities. When agreed with all these communities, a joint proposal to the EU FP6 Access to Large Infrastructures, together with related training and PHARE programmes, will be developed. Various bi-national and multi-national cooperative arrangements have already been stimulated by these meetings.

An extremely ambitious programme, bringing together for the first time all of Europe national telescope operators, has succeeded admirably.

It is proposed to develop, in detail, methods to enhance the scientific and research training roles of extant 2-4m telescopes; to implement bi-national and multi-national coordination of operations and developments, and to propose to the EU FP6 programme a Europe-wide training and research capability.

5.3.4. *Activity 5: The Science Case for Extremely Large Telescopes*

An immediate goal of this working group is to develop the science case for future large telescopes, as that would form the basis for specific technological developments. An ancillary goal was to bring together the European astronomy community to support an agreed future program of major infrastructure developments, aimed at putting Europe at the head of the world.

This science case will do the following:

i) define the technological studies and developments which are necessary to build the telescope; ii) form the basis for future proposals for national and EU funding support for development and construction of a world-leading facility.

A major international workshop was held in Edinburgh, September 2000, resulting in the 58 participants identifying and outlining key scientific challenges which enhances the case for future technologies.

The material was assembled into a web-based "skeleton science case", including technical background and performance comparisons between space-based and ground-based facilities. The science sessions (planets and stars, stars and galaxies, galaxies and cosmology) were summarized by the session chairs, and other contributions from participants were included or linked. A software performance simulator is under development, while the whole web-based information package forms the basis for further development at the next planned workshop in the series during Summer 2001.

The current text is available at www.astro-opticon.org/ELT.html

The early intention, to initiate development of the science case for future extremely large telescopes, has been admirably achieved. A draft science case exists, based on full international participation, which this will be further developed in the near future. A pleasing outcome which exceeded intention was the very high degree of international interest and involvement in the planning and implementation of next generation facilities.

5.4. ACTIVITY 6: COMMON ACTIVITIES INVOLVING ALL OF ASTRONOMY

Multinational organizations, such as the EU, and national funding agencies, expect research communities to agree their priorities internally. Competing proposals to national/international agencies from inside a sub-discipline are mutually destructive. Conversely, where several subdisciplines can benefit from a similar infrastructure investment, the case for that investment is strengthened. An topical example in investment in high-bandwidth communications infrastructure (the internet, GRID, and their successors), where all science will benefit.

Coordinated approaches to funding agencies and strategy forums for major projects are thus both necessary and desirable. There is at present no natural forum in Europe to coordinate such approaches. Thus, joint efforts by OPTICON and JIVE/EVN are underway, to establish relevant communications. This will be initiated with public meetings at the Joint European Astronomy Meetings.

6. PUBLICITY, and Public Awareness

A challenge for any new organization, especially for one involving funding agencies from many countries, is to ensure that the wider community is both fully involved and fully informed of activities and opportunities.

For OPTICON, a conscious decision was made that the first major effort to disseminate results of OPTICON's activities had to await those activities. That is, wide advertising would await some positive results. This rather non-commercial approach has been followed.

The first major successes of OPTICON are now in place.

- The Astrophysical Virtual Observatory developments and initial funding have been obtained.
- Coordinated developments of common infrastructures have been agreed, and funded.
- Substantial development work towards an Elite Fellowship programme is funded, and underway.
- The Science Case for a large Telescope is under multi-national development.
- Europe's operators of existing telescopes are meeting and working together.

All these successes have been achieved under the sponsorship of OPTICON. All have been achieved in the first year of activity. Now is the time to address wider questions, and inform the wider community. This is the next challenge for OPTICON.